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FIG. 1

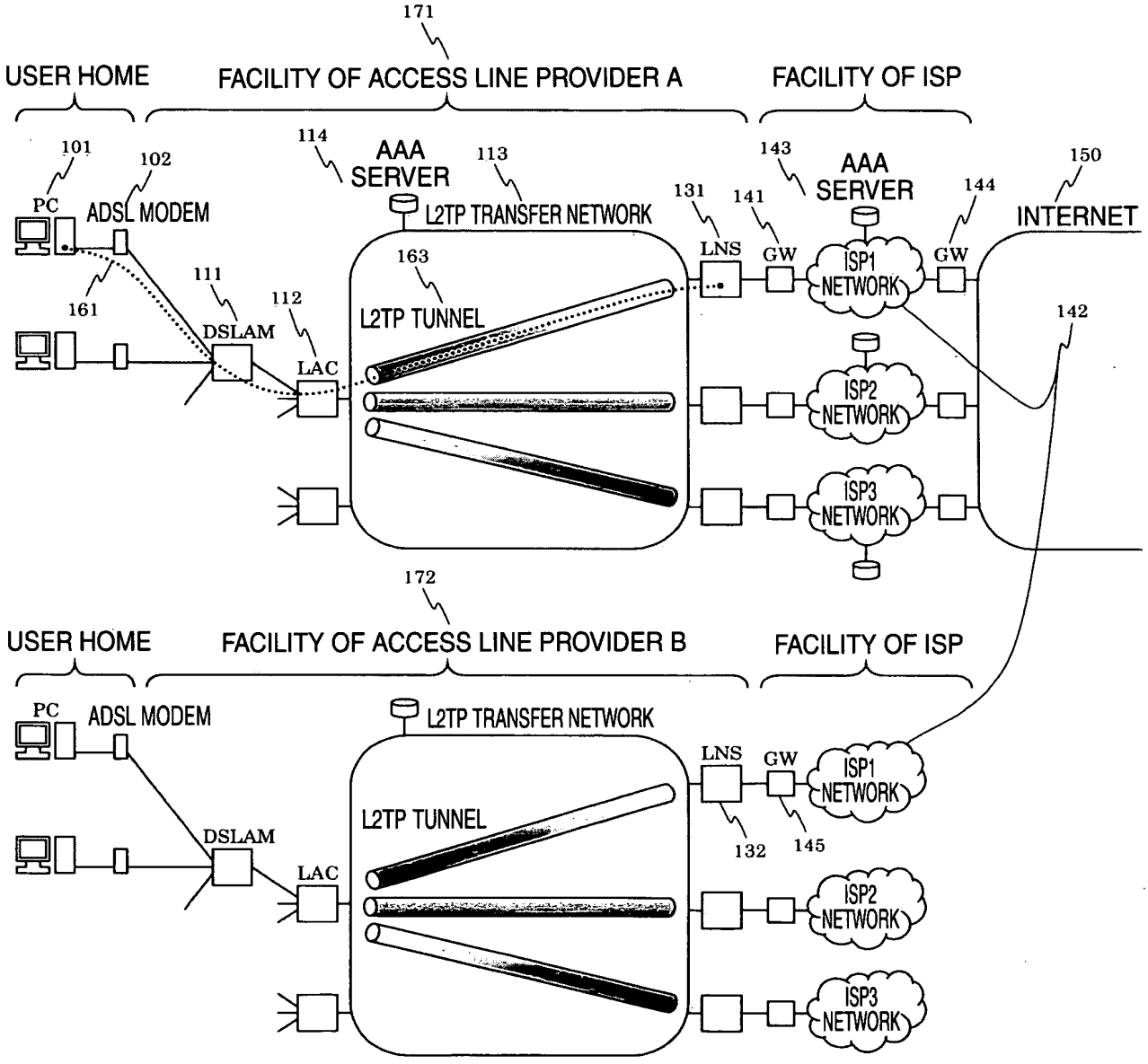


FIG. 2

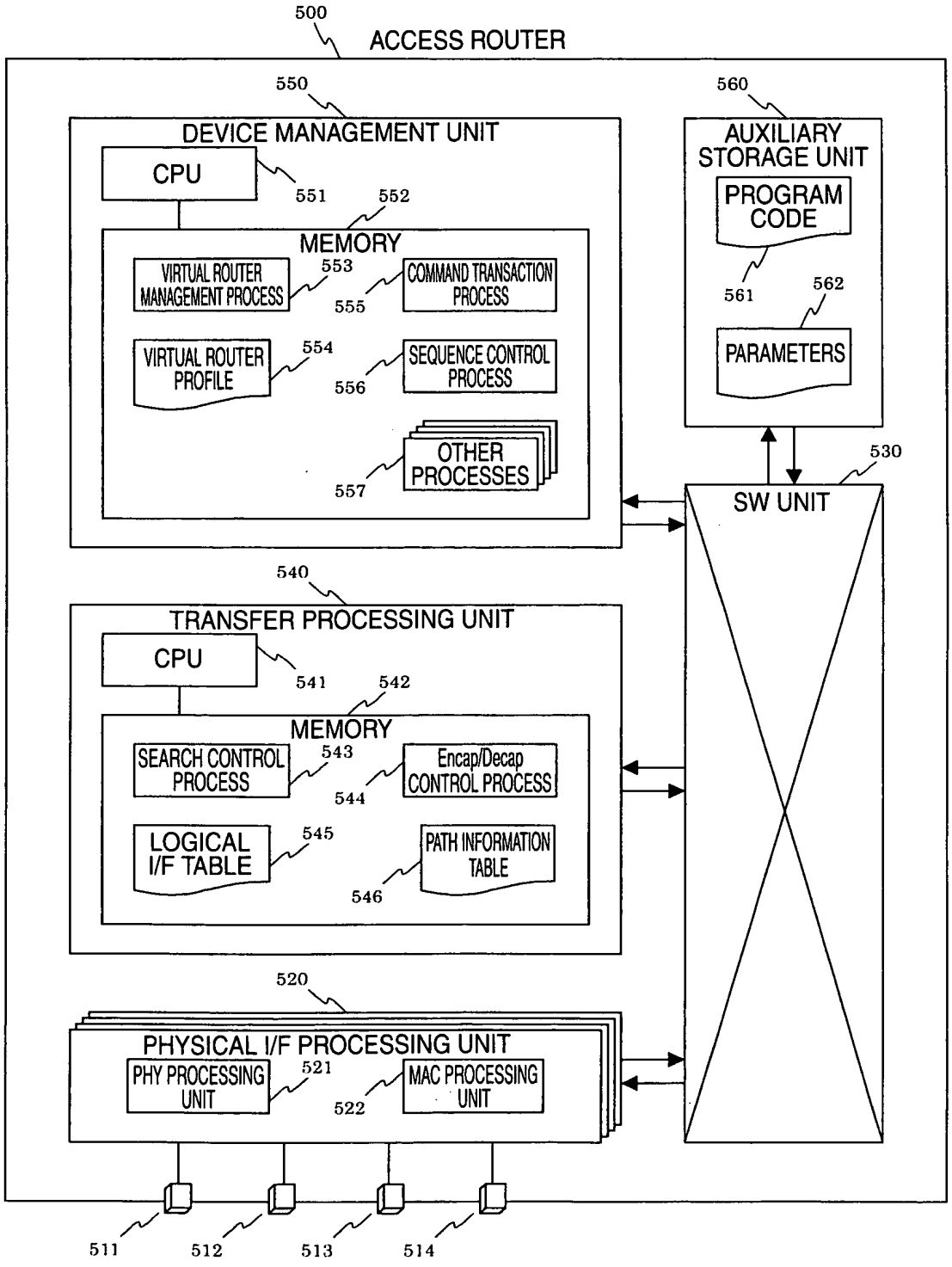

500
ACCESS ROUTER
550
DEVICE MANAGEMENT UNIT
CPU
551
552
MEMORY
VIRTUAL ROUTER MANAGEMENT PROCESS
553
555
COMMAND TRANSACTION PROCESS
VIRTUAL ROUTER PROFILE
554
556
SEQUENCE CONTROL PROCESS
OTHER PROCESSES
557
560
AUXILIARY STORAGE UNIT
PROGRAM CODE
561
562
PARAMETERS
530
SW UNIT
540
TRANSFER PROCESSING UNIT
CPU
541
542
MEMORY
SEARCH CONTROL PROCESS
543
544
Encap/Decap CONTROL PROCESS
LOGICAL I/F TABLE
545
546
PATH INFORMATION TABLE
520
PHYSICAL I/F PROCESSING UNIT
PHY PROCESSING UNIT
521
522
MAC PROCESSING UNIT
511
512
513
514

FIG. 3

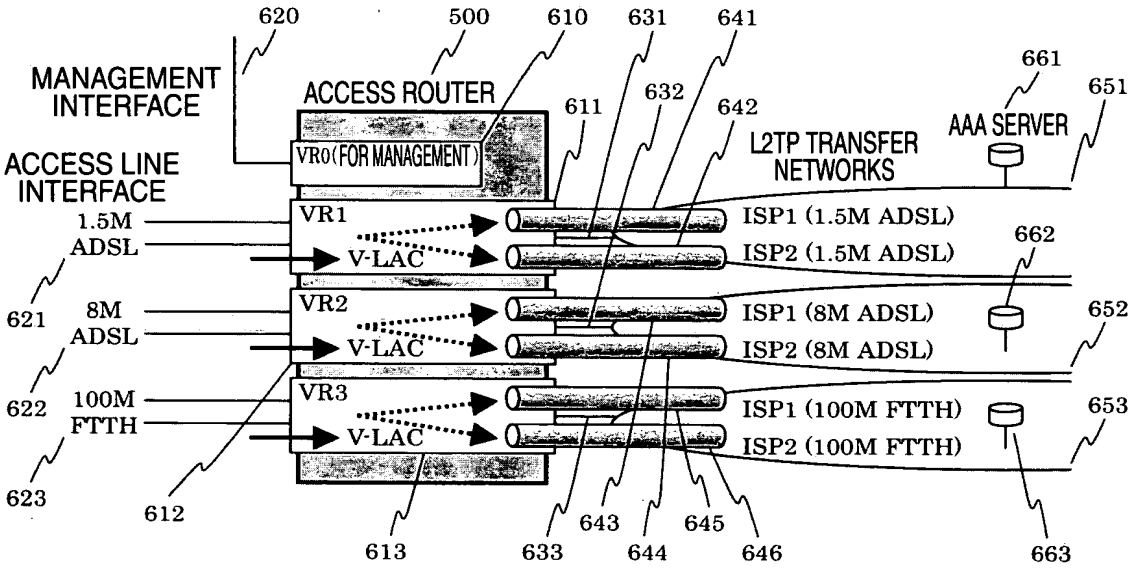

620
500
610
631
641
661
651
MANAGEMENT INTERFACE
ACCESS ROUTER
611
632
642
AAA SERVER
L2TP TRANSFER NETWORKS
ACCESS LINE INTERFACE
VR0 (FOR MANAGEMENT)
1.5M ADSL
VR1
V-LAC
ISP1 (1.5M ADSL)
ISP2 (1.5M ADSL)
662
621
8M ADSL
VR2
V-LAC
ISP1 (8M ADSL)
ISP2 (8M ADSL)
652
622
100M FTTH
VR3
V-LAC
ISP1 (100M FTTH)
ISP2 (100M FTTH)
653
623
612
613
633
643
644
645
646
663

FIG. 4

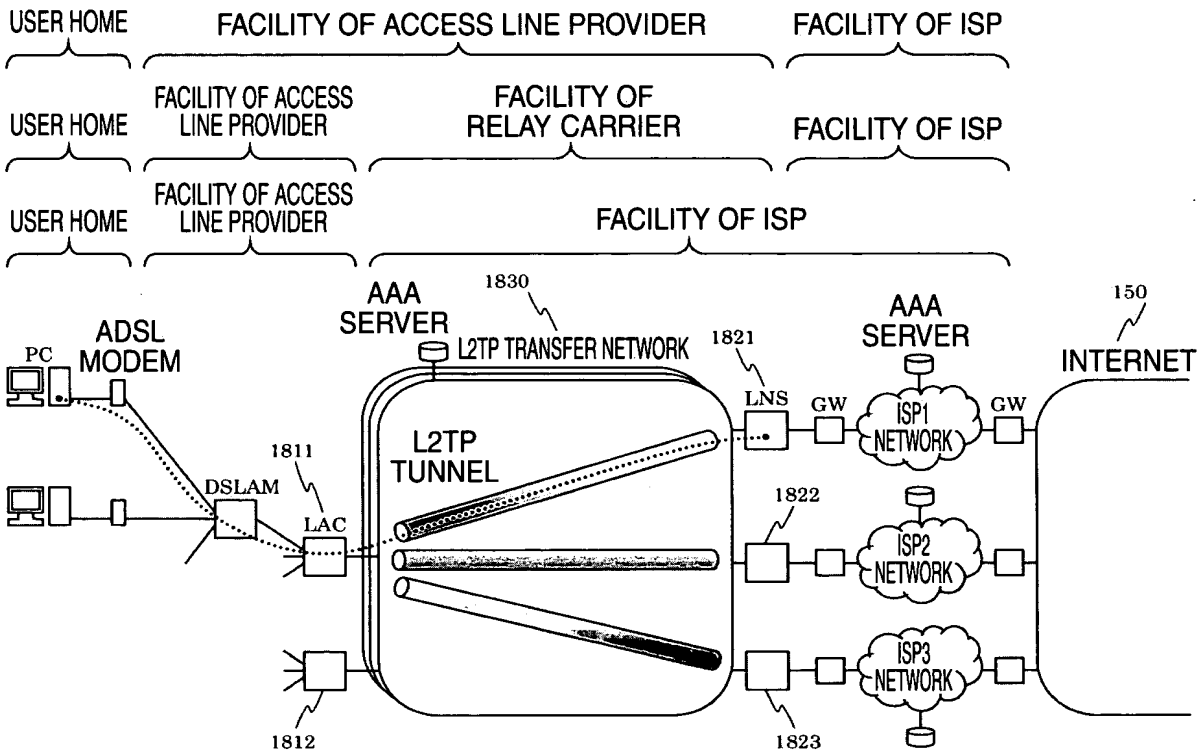

USER HOME
FACILITY OF ACCESS LINE PROVIDER
FACILITY OF ISP
USER HOME
FACILITY OF ACCESS LINE PROVIDER
FACILITY OF RELAY CARRIER
FACILITY OF ISP
USER HOME
FACILITY OF ACCESS LINE PROVIDER
FACILITY OF ISP
AAA SERVER
1830
L2TP TRANSFER NETWORK
1821
AAA SERVER
150
INTERNET
PC
ADSL MODEM
LNS
GW
ISP1 NETWORK
GW
1811
L2TP TUNNEL
DSLAM
LAC
1822
ISP2 NETWORK
ISP3 NETWORK
1812
1823

FIG. 5A

	2001	2002	2003	2004	2005	2006	2007
	VIRTUAL ROUTER	PHYSICAL I/F	PROTOCOL	LOGICAL I/F	Rx/Tx	ACTION	VIRTUAL ROUTER
2021	-	ATM_11	PPPoE	PVC_11	Rx	Decap_PPPoE	VR_1
2022	VR_1	-	PPP	PPPoE_11	Rx	Map_L2TP	VR_1
2023	VR_1	-	PPP	Session_12	Tx	Encap_L2TP	VR_1
2024	VR_1	-	L2TP	Tunnel_12	Tx	Encap_UDP/IP	VR_1
2025	VR_1	-	IP	UDP_1701	Tx	Route	VR_1
2027	VR_1	Ether_12	IP	-	Tx	Forward	-
2031	-	Ether_12	IP	-	Rx	Route	VR_1
2033	VR_1	-	UDP/IP	UDP_1701	Rx	Decap_UDP/IP	VR_1
2034	VR_1	-	L2TP	Tunnel_12	Rx	Decap_L2TP	VR_1
2035	VR_1	-	PPP	Session_12	Rx	Map_PPPoE	VR_1
2036	VR_1	-	PPP	PPPoE_11	Tx	Encap_PPPoE	VR_1
2037	VR_1	ATM_11	PPPoE	PVC_11	Tx	Forward	-

FIG. 5B

	2011	2012	2013	2014	2015	2016	2017
	VIRTUAL ROUTER	DESTINATION IP ADDRESS	ADDRESS MASK	SELF-ADDRESSED	NextHop ADDRESS	PHYSICAL I/F	LOGICAL I/F
2026	VR_1	192.168.20.1	255.255.255.0	0	192.168.10.2	Ether_12	-
2032	VR_1	192.168.10.1	255.255.255.0	1	-	-	UDP_1701

FIG. 6

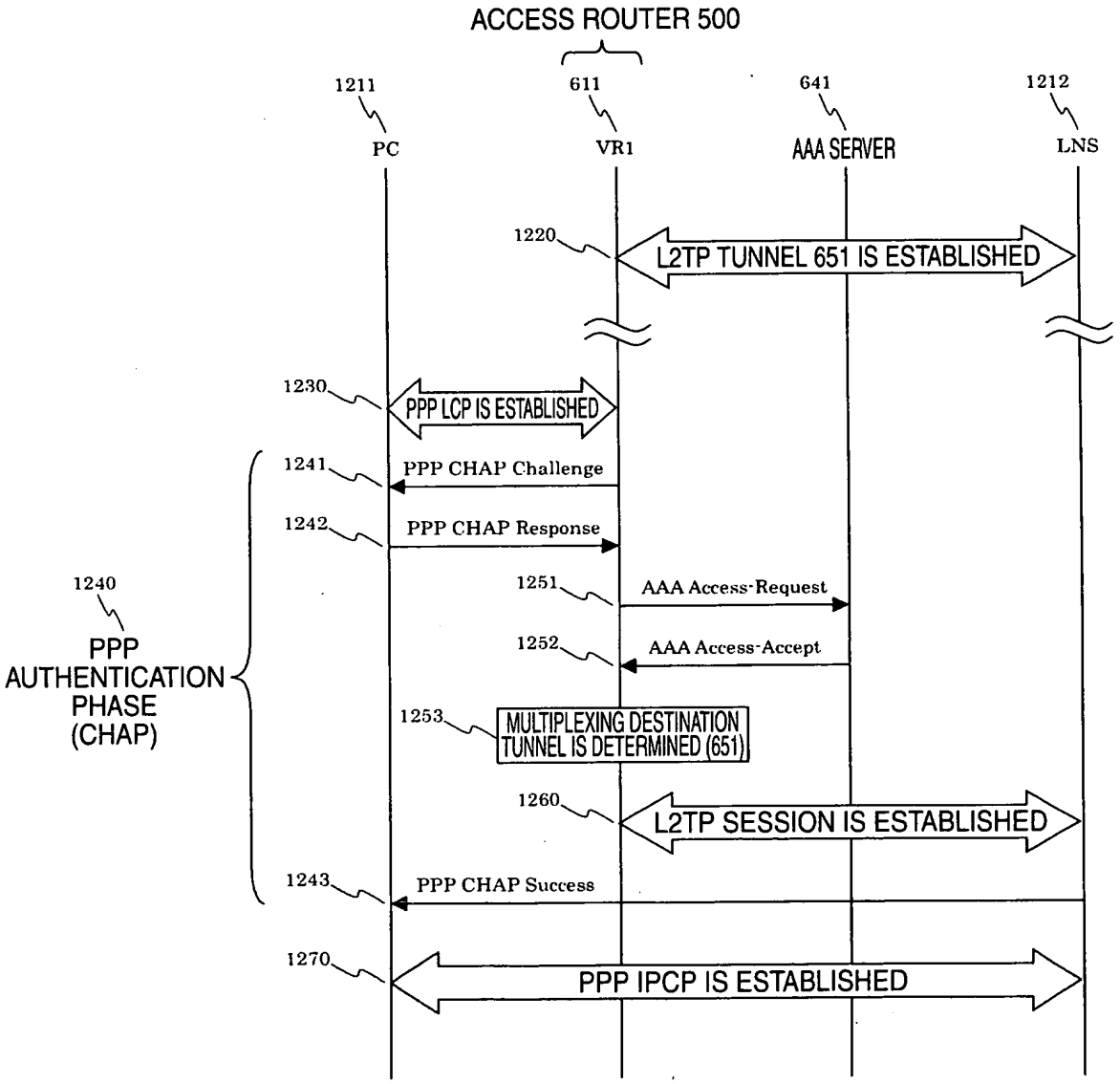

ACCESS ROUTER 500
1211
PC
611
VR1
641
AAA SERVER
1212
LNS
1220
L2TP TUNNEL 651 IS ESTABLISHED
1230
PPP LCP IS ESTABLISHED
1241
PPP CHAP Challenge
1242
PPP CHAP Response
1240
PPP AUTHENTICATION PHASE (CHAP)
1251
AAA Access-Request
1252
AAA Access-Accept
1253
MULTIPLEXING DESTINATION TUNNEL IS DETERMINED (651)
1260
L2TP SESSION IS ESTABLISHED
1243
PPP CHAP Success
1270
PPP IPCP IS ESTABLISHED

FIG. 7

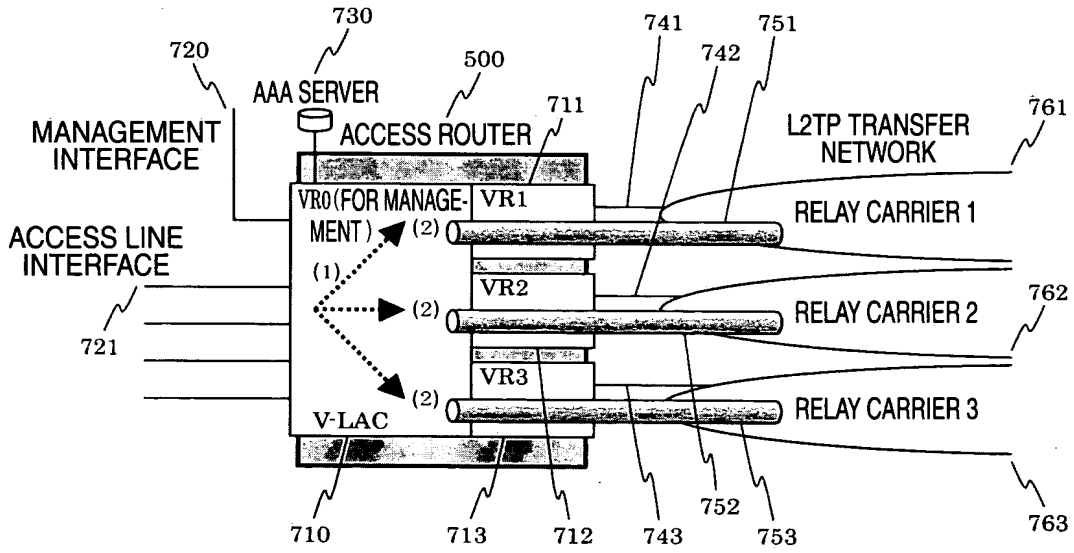

730
720
AAA SERVER
500
741
751
742
711
761
MANAGEMENT INTERFACE
ACCESS ROUTER
L2TP TRANSFER NETWORK
VR0 (FOR MANAGE-MENT)
VR1
RELAY CARRIER 1
ACCESS LINE INTERFACE
(1)
(2)
VR2
762
RELAY CARRIER 2
721
(2)
VR3
(2)
RELAY CARRIER 3
V-LAC
710
713
712
743
752
753
763

FIG. 8A

	2101 VIRTUAL ROUTER	2102 PHYSICAL I/F	2103 PROTOCOL	2104 LOGICAL I/F	2105 Rx/Tx	2106 ACTION	2107 VIRTUAL ROUTER
2121	-	ATM_11	PPPoE	PVC_11	Rx	Decap_PPPoE	VR_0
2122	VR_0	-	PPP	PPPoE_11	Rx	Map_L2TP	VR_0
2123	VR_0	-	PPP	Session_12	Tx	Encap_L2TP	VR_1
2124	VR_1	-	L2TP	Tunnel_12	Tx	Encap_UDP/IP	VR_1
2125	VR_1	-	IP	UDP_1701	Tx	Route	VR_1
2127	VR_1	Ether_12	IP	-	Tx	Forward	-
2131	-	Ether_12	IP	-	Rx	Route	VR_1
2133	VR_1	-	UDP/IP	UDP_1701	Rx	Decap_UDP/IP	VR_0
2134	VR_0	-	L2TP	Tunnel_12	Rx	Decap_L2TP	VR_0
2135	VR_0	-	PPP	Session_12	Rx	Map_PPPoE	VR_0
2136	VR_0	-	PPP	PPPoE_11	Tx	Encap_PPPoE	VR_0
2137	VR_0	ATM_11	PPPoE	PVC_11	Tx	Forward	-

FIG. 8B

	2111 VIRTUAL ROUTER	2112 DESTINATION IP ADDRESS	2113 ADDRESS MASK	2114 SELF-ADDRESSED	2115 NextHop ADDRESS	2116 PHYSICAL I/F	2117 LOGICAL I/F
2126	VR_1	192.168.20.1	255.255.255.0	0	192.168.10.2	Ether_12	-
2132	VR_1	192.168.10.1	255.255.255.0	1	-	-	UDP_1701

FIG. 9

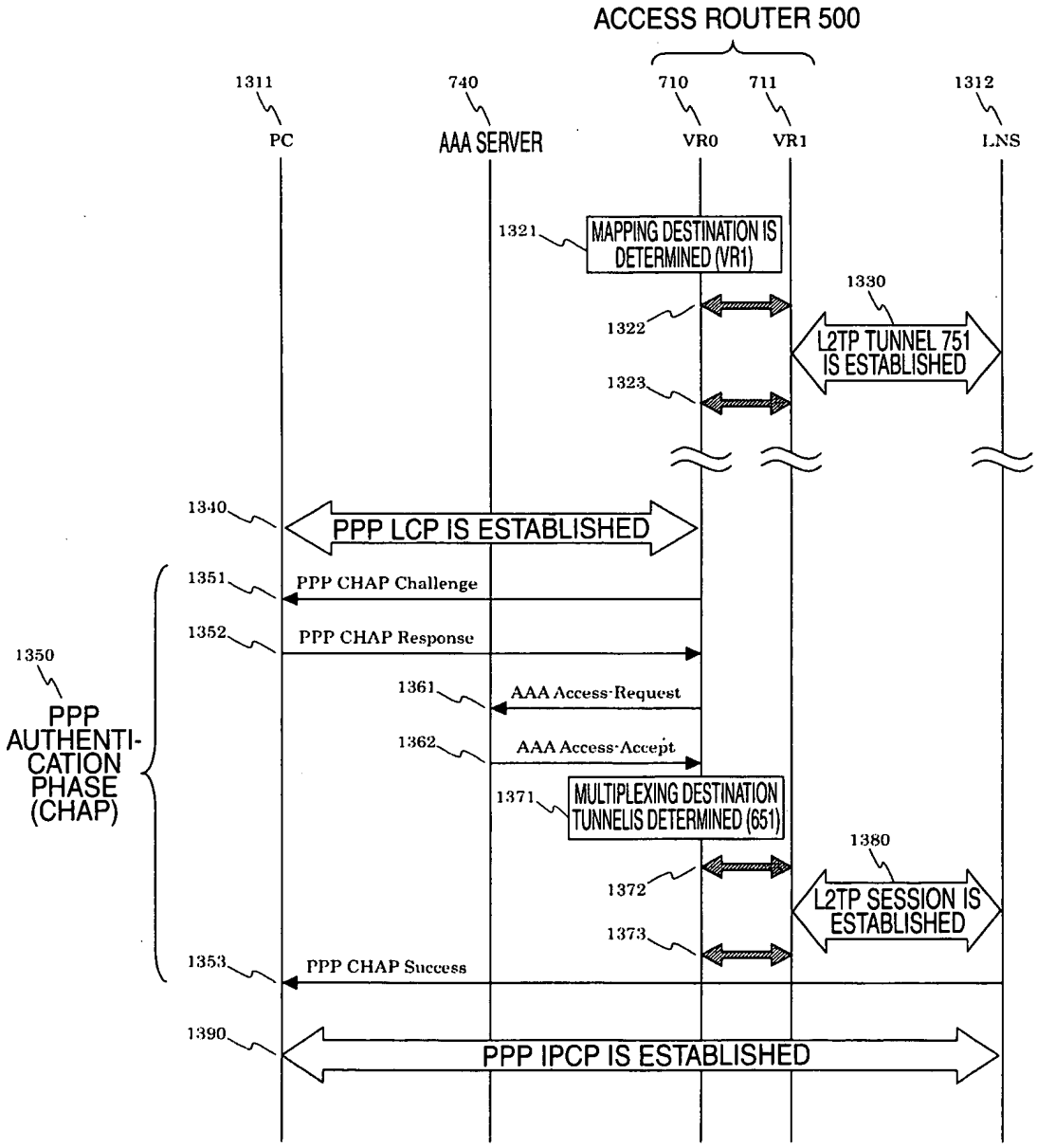

ACCESS ROUTER 500
1311
PC
740
AAA SERVER
710
VR0
711
VR1
1312
LNS
1321
MAPPING DESTINATION IS DETERMINED (VR1)
1330
1322
L2TP TUNNEL 751 IS ESTABLISHED
1323
1340
PPP LCP IS ESTABLISHED
1351
PPP CHAP Challenge
1352
PPP CHAP Response
1350
PPP AUTHENTI-CATION PHASE (CHAP)
1361
AAA Access-Request
1362
AAA Access-Accept
1371
MULTIPLEXING DESTINATION TUNNELIS DETERMINED (651)
1380
1372
L2TP SESSION IS ESTABLISHED
1373
1353
PPP CHAP Success
1390
PPP IPCP IS ESTABLISHED

FIG. 10

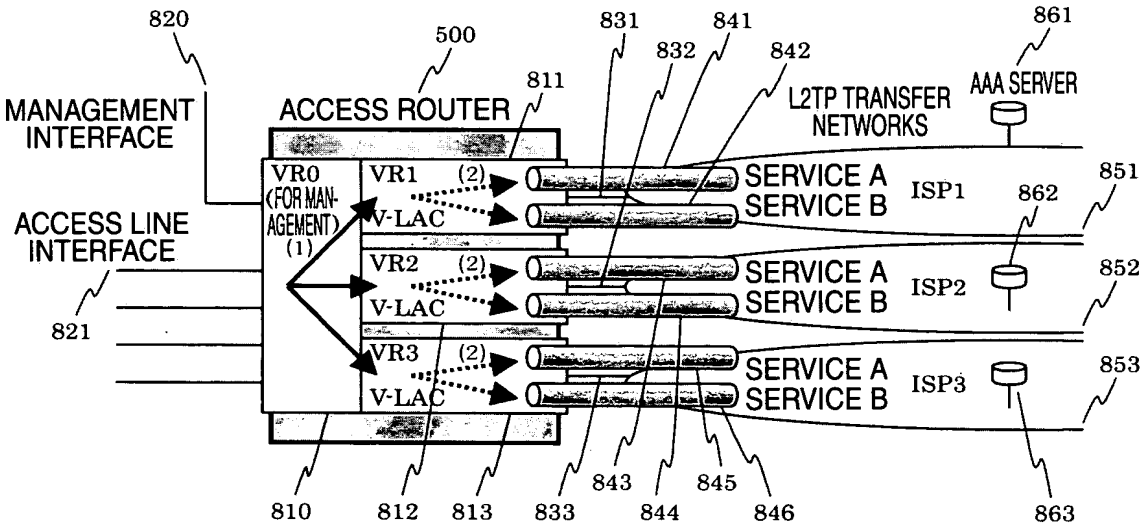

820
500
831
841
861
832
842
811
MANAGEMENT INTERFACE
ACCESS ROUTER
L2TP TRANSFER NETWORKS
AAA SERVER
VR0 (FOR MANAGEMENT) (1)
VR1 (2)
V-LAC
SERVICE A
SERVICE B
ISP1
851
862
ACCESS LINE INTERFACE
VR2 (2)
V-LAC
SERVICE A
SERVICE B
ISP2
852
821
VR3 (2)
V-LAC
SERVICE A
SERVICE B
ISP3
853
843
845
810
812
813
833
844
846
863

FIG. 11A

	2201 VIRTUAL ROUTER	2202 PHYSICAL I/F	2203 PROTOCOL	2204 LOGICAL I/F	2205 Rx/Tx	2206 ACTION	2207 VIRTUAL ROUTER
2221	-	ATM_11	PPPoE	PVC_11	Rx	Decap_PPPoE	VR_0
2222	VR_0	-	PPP	PPPoE_11	Rx	Map_L2TP	VR_1
2223	VR_1	-	PPP	Session_12	Tx	Encap_L2TP	VR_1
2224	VR_1	-	L2TP	Tunnel_12	Tx	Encap_UDP/IP	VR_1
2225	VR_1	-	IP	UDP_1701	Tx	Route	VR_1
2227	VR_1	Ether_12	IP	-	Tx	Forward	-
2231	-	Ether_12	IP	-	Rx	Route	VR_1
2233	VR_1	-	UDP/IP	UDP_1701	Rx	Decap_UDP/IP	VR_1
2234	VR_1	-	L2TP	Tunnel_12	Rx	Decap_L2TP	VR_0
2235	VR_0	-	PPP	Session_12	Rx	Map_PPPoE	VR_0
2236	VR_0	-	PPP	PPPoE_11	Tx	Encap_PPPoE	VR_0
2237	VR_0	ATM_11	PPPoE	PVC_11	Tx	Forward	-

FIG. 11B

	2211 VIRTUAL ROUTER	2212 DESTINATION IP ADDRESS	2213 ADDRESS MASK	2214 SELF-ADDRESSED	2215 NextHop ADDRESS	2216 PHYSICAL I/F	2217 LOGICAL I/F
2226	VR_1	192.168.20.1	255.255.255.0	0	192.168.10.2	Ether_12	-
2232	VR_1	192.168.10.1	255.255.255.0	1	-	-	UDP_1701

FIG. 12

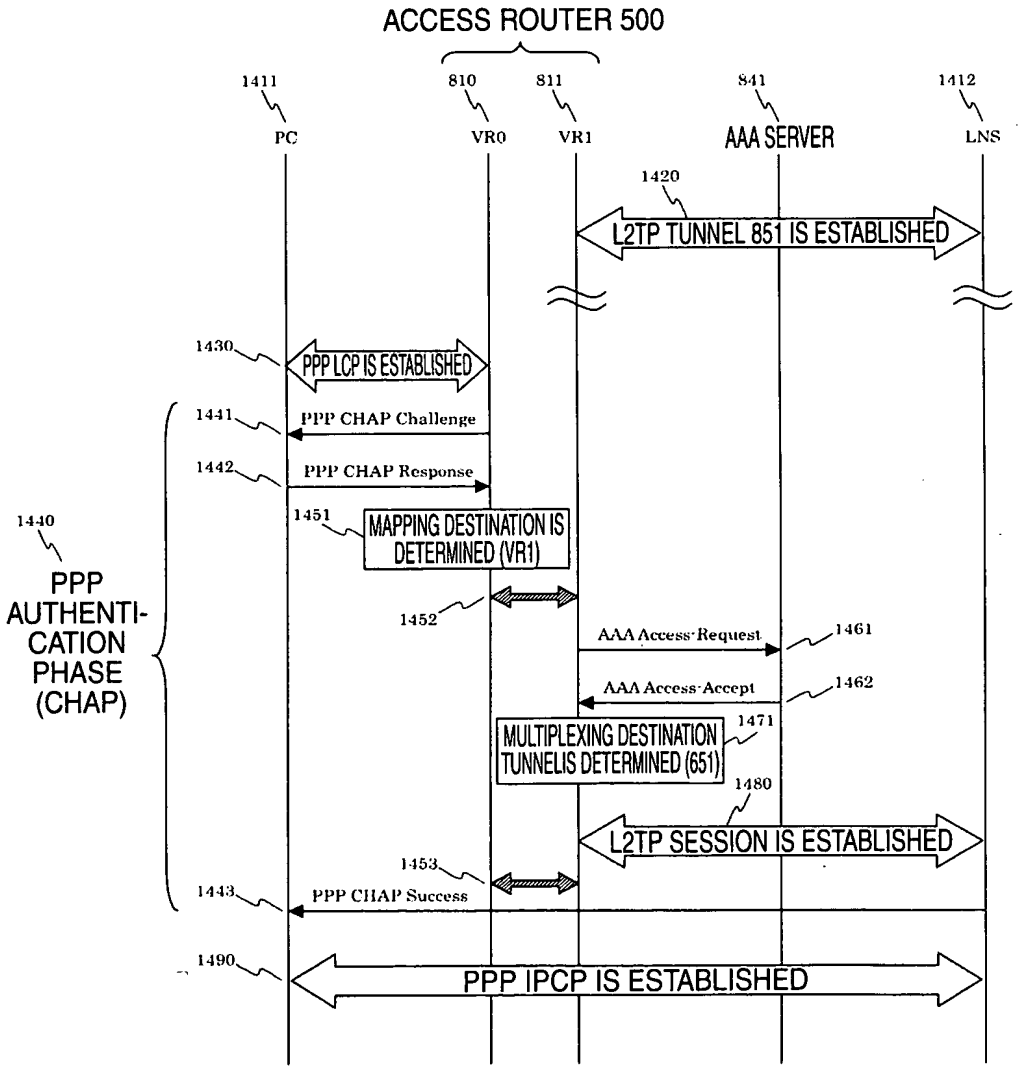

ACCESS ROUTER 500
1411
PC
810
VR0
811
VR1
841
AAA SERVER
1412
LNS
1420
L2TP TUNNEL 851 IS ESTABLISHED
1430
PPP LCP IS ESTABLISHED
1441
PPP CHAP Challenge
1442
PPP CHAP Response
1451
MAPPING DESTINATION IS DETERMINED (VR1)
1440
PPP AUTHENTI-CATION PHASE (CHAP)
1452
AAA Access-Request
1461
AAA Access-Accept
1462
MULTIPLEXING DESTINATION TUNNELIS DETERMINED (651)
1471
1480
L2TP SESSION IS ESTABLISHED
1453
1443
PPP CHAP Success
1490
PPP IPCP IS ESTABLISHED

FIG. 13

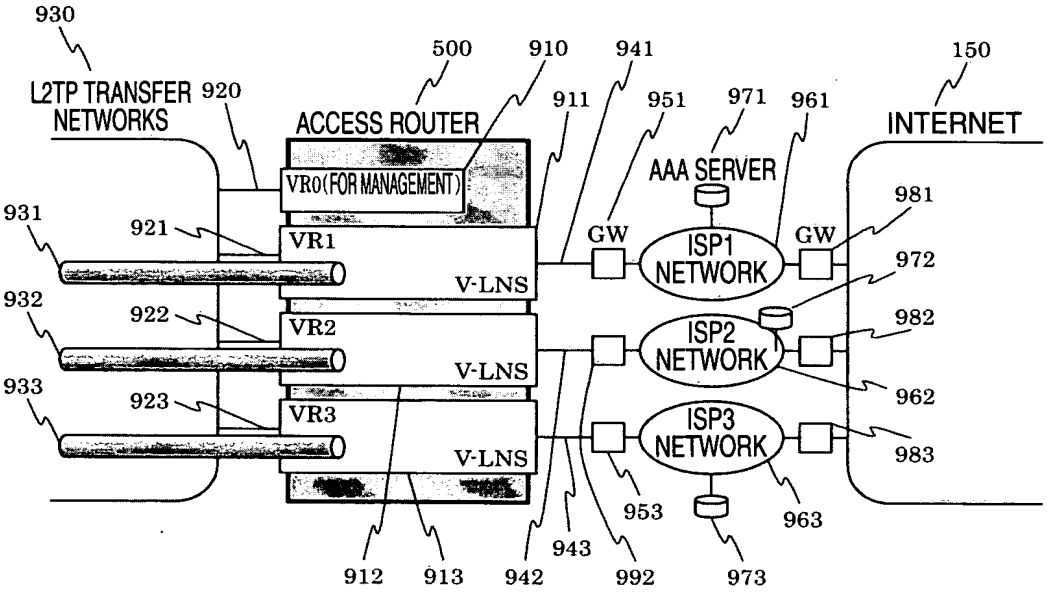

930
L2TP TRANSFER NETWORKS
920
500
ACCESS ROUTER
910
911
941
951
971
961
150
INTERNET
AAA SERVER
VR0(FOR MANAGEMENT)
931
921
VR1
V-LNS
GW
ISP1 NETWORK
GW
981
932
922
VR2
V-LNS
ISP2 NETWORK
972
982
933
923
VR3
V-LNS
ISP3 NETWORK
962
983
912
913
942
943
992
953
963
973

FIG. 14A

	2301 VIRTUAL ROUTER	2302 PHYSICAL I/F	2303 PROTOCOL	2304 LOGICAL I/F	2305 Rx/Tx	2306 ACTION	2307 VIRTUAL ROUTER
2321	-	Ether_21	IP	-	Rx	Route	VR_1
2323	VR_1	-	UDP/IP	UDP_1701	Rx	Decap_UDP/IP	VR_1
2324	VR_1	-	L2TP	Tunnel_21	Rx	Decap_L2TP	VR_1
2325	VR_1	-	PPP	Session_21	Rx	Decap_PPP	VR_1
2326	VR_1	-	IP	Session_21	Rx	Route	VR_1
2328	VR_1	Ether_22	IP	-	Tx	Forward	-
2331	-	Ether_22	IP	-	Rx	Route	VR_1
2333	VR_1	-	IP	Session_21	Tx	Encap_PPP	VR_1
2334	VR_1	-	PPP	Session_21	Tx	Encap_L2TP	VR_1
2335	VR_1	-	L2TP	Tunnel_21	Tx	Encap_UDP/IP	VR_1
2336	VR_1	-	IP	UDP_1701	Tx	Route	VR_1
2338	VR_1	Ether_21	IP	-	Tx	Forward	-

FIG. 14B

	2311 VIRTUAL ROUTER	2312 DESTINATION IP ADDRESS	2313 ADDRESS MASK	2314 SELF-ADDRESSED	2315 NextHop ADDRESS	2316 PHYSICAL I/F	2317 LOGICAL I/F
2322	VR_1	192.168.20.1	255.255.255.0	1	-	-	UDP_1701
2327	VR_1	158.214.2.5	255.255.255.0	0	158.214.1.1	Ether_22	-
2332	VR_1	133.144.69.112	255.255.255.0	0	-	-	Session_21
2337	VR_1	192.168.10.1	255.255.255.0	0	192.168.20.2	Ether_21	-

FIG. 15

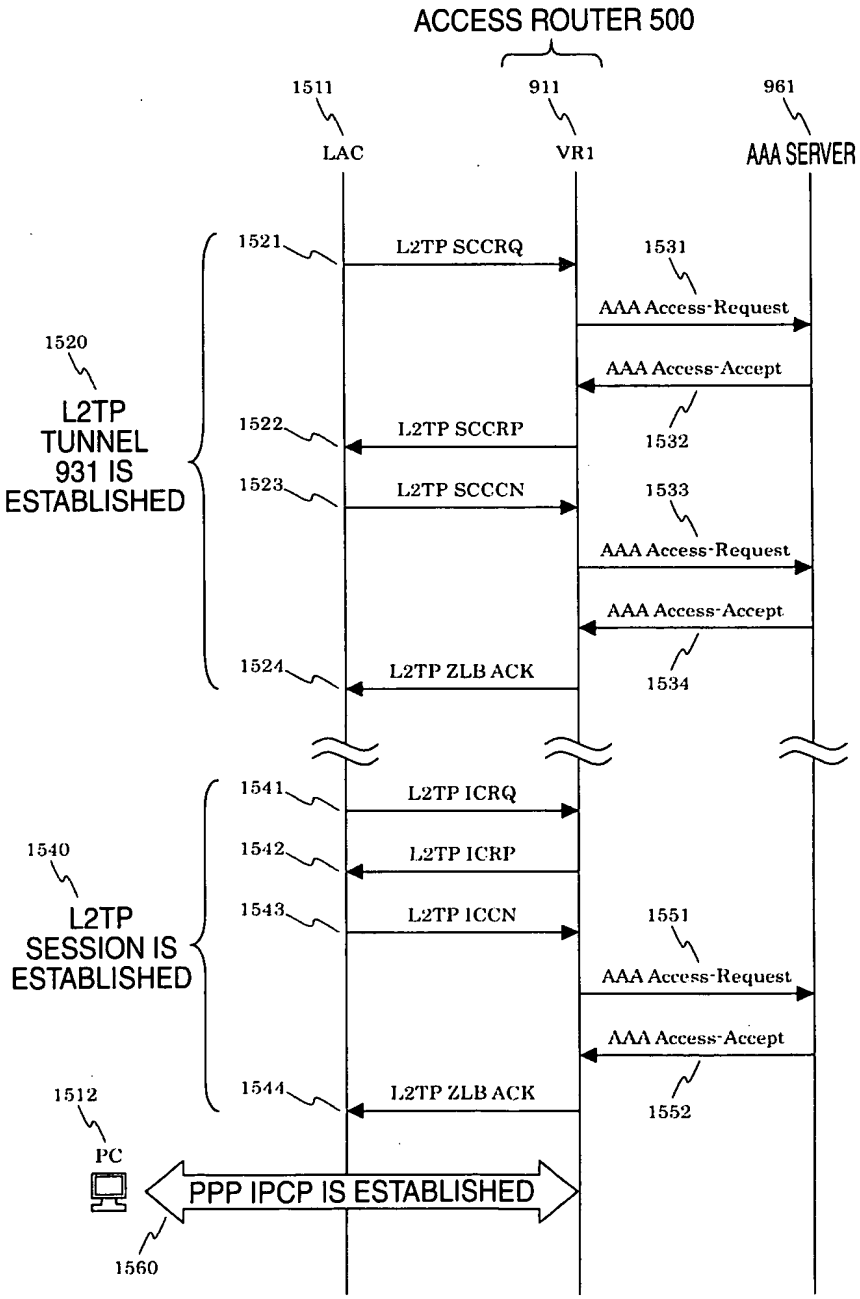

ACCESS ROUTER 500
1511
LAC
911
VR1
961
AAA SERVER
1521
L2TP SCCRQ
1531
AAA Access-Request
1520
L2TP TUNNEL 931 IS ESTABLISHED
AAA Access-Accept
1532
1522
L2TP SCCRP
1523
L2TP SCCCN
1533
AAA Access-Request
AAA Access-Accept
1534
1524
L2TP ZLB ACK
1541
L2TP ICRQ
1540
L2TP SESSION IS ESTABLISHED
1542
L2TP ICRP
1543
L2TP ICCN
1551
AAA Access-Request
AAA Access-Accept
1552
1544
L2TP ZLB ACK
1512
PC
PPP IPCP IS ESTABLISHED
1560

FIG. 16

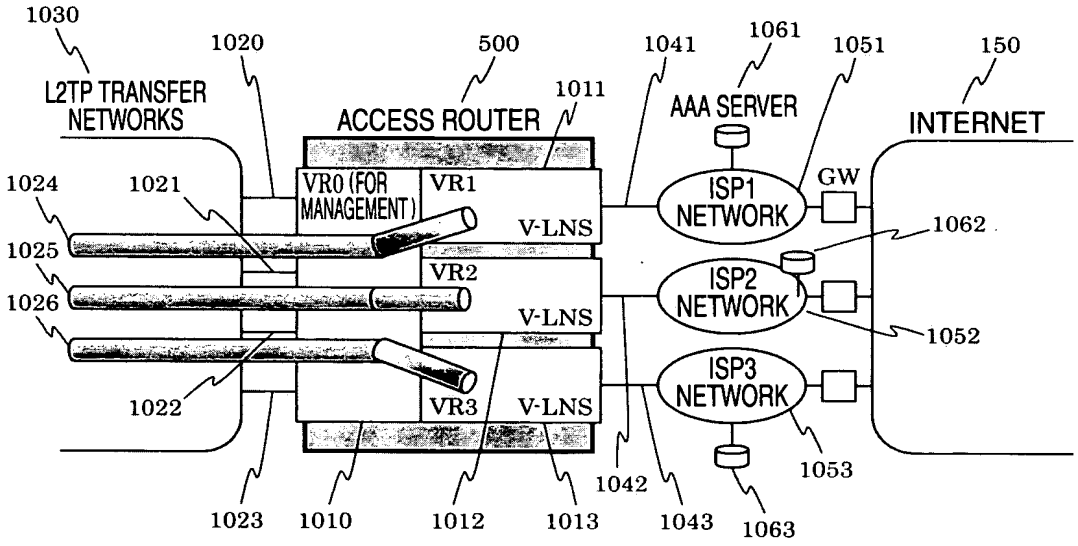

1030
L2TP TRANSFER NETWORKS
1020
500
ACCESS ROUTER
1011
1041
1061
AAA SERVER
1051
150
INTERNET
1024
1021
VR0 (FOR MANAGEMENT)
VR1
V-LNS
ISP1 NETWORK
GW
1062
1025
VR2
ISP2 NETWORK
1026
V-LNS
1052
1022
VR3
V-LNS
ISP3 NETWORK
1053
1042
1023
1010
1012
1013
1043
1063

FIG. 17A

	2401	2402	2403	2404	2405	2406	2407
	VIRTUAL ROUTER	PHYSICAL I/F	PROTOCOL	LOGICAL I/F	Rx/Tx	ACTION	VIRTUAL ROUTER
2421	-	Ether_21	IP	-	Rx	Route	VR_0
2423	VR_0	-	UDP/IP	UDP_1701	Rx	Decap_UDP/IP	VR_1
2424	VR_1	-	L2TP	Tunnel_21	Rx	Decap_L2TP	VR_1
2425	VR_1	-	PPP	Session_21	Rx	Decap_PPP	VR_1
2426	VR_1	-	IP	Session_21	Rx	Route	VR_1
2428	VR_1	Ether_22	IP	-	Tx	Forward	-
2431	-	Ether_22	IP	-	Rx	Route	VR_1
2433	VR_1	-	IP	Session_21	Tx	Encap_PPP	VR_1
2434	VR_1	-	PPP	Session_21	Tx	Encap_L2TP	VR_0
2435	VR_0	-	L2TP	Tunnel_21	Tx	Encap_UDP/IP	VR_0
2436	VR_0	-	IP	UDP_1701	Tx	Route	VR_0
2438	VR_0	Ether_21	IP	-	Tx	Forward	-

FIG. 17B

	2411	2412	2413	2414	2415	2416	2417
	VIRTUAL ROUTER	DESTINATION IP ADDRESS	ADDRESS MASK	SELF-ADDRESSED	NextHop ADDRESS	PHYSICAL I/F	LOGICAL I/F
2422	VR_0	192.168.20.1	255.255.255.0	1	-	-	UDP_1701
2427	VR_1	158.214.2.5	255.255.255.0	0	158.214.1.1	Ether_22	-
2432	VR_1	133.144.69.112	255.255.255.0	0	-	-	Session_21
2437	VR_0	192.168.10.1	255.255.255.0	0	192.168.20.2	Ether_21	-

FIG. 18

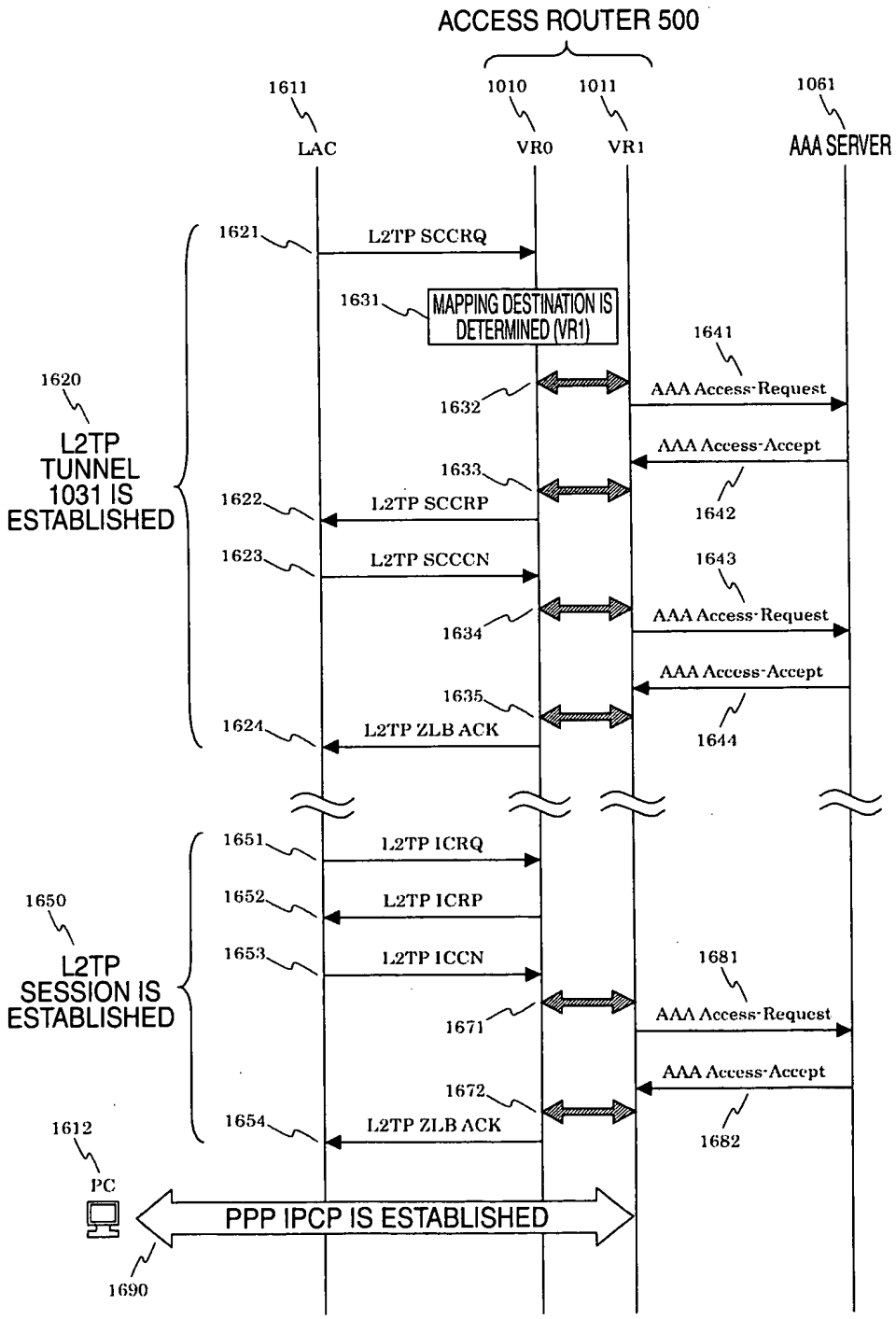

ACCESS ROUTER 500
1611
LAC
1010
VR0
1011
VR1
1061
AAA SERVER
1621
L2TP SCCRQ
1631
MAPPING DESTINATION IS DETERMINED (VR1)
1641
AAA Access-Request
1620
L2TP TUNNEL 1031 IS ESTABLISHED
1632
AAA Access-Accept
1633
1642
1622
L2TP SCCRP
1623
L2TP SCCCN
1643
AAA Access-Request
1634
AAA Access-Accept
1635
1644
1624
L2TP ZLB ACK
1651
L2TP ICRQ
1650
1652
L2TP ICRP
L2TP SESSION IS ESTABLISHED
1653
L2TP ICCN
1681
AAA Access-Request
1671
AAA Access-Accept
1672
1682
1654
L2TP ZLB ACK
1612
PC
PPP IPCP IS ESTABLISHED
1690

FIG. 19

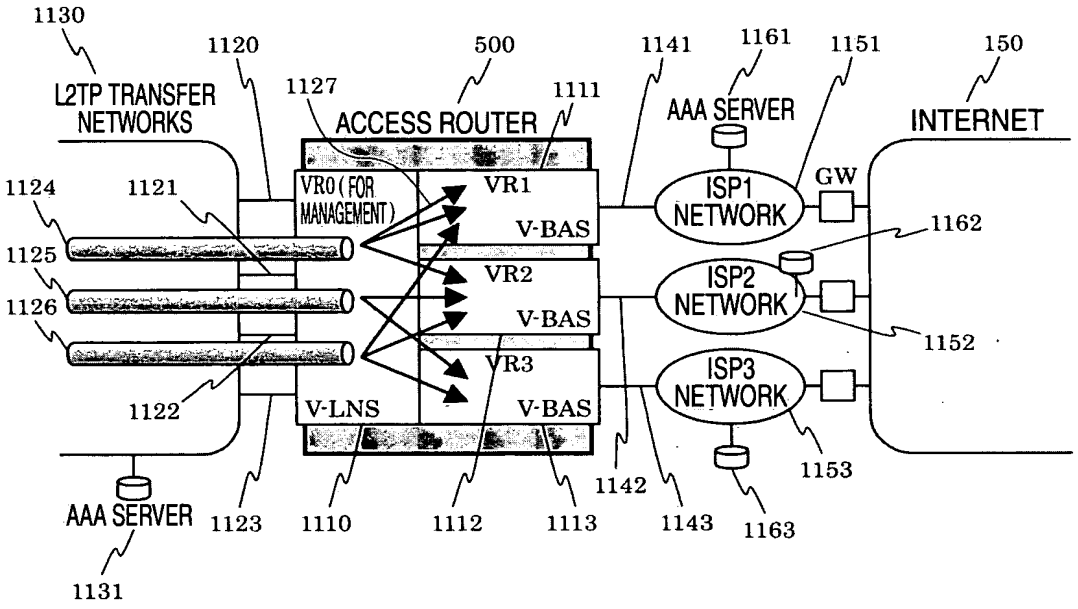

1130
1120
500
1141
1161
1151
150
L2TP TRANSFER NETWORKS
1127
ACCESS ROUTER
1111
AAA SERVER
INTERNET
1124
1121
VR0 (FOR MANAGEMENT)
VR1
V-BAS
ISP1 NETWORK
GW
1125
1162
VR2
V-BAS
ISP2 NETWORK
1126
1152
VR3
ISP3 NETWORK
1122
V-LNS
V-BAS
1153
1142
AAA SERVER
1123
1110
1112
1113
1143
1163
1131

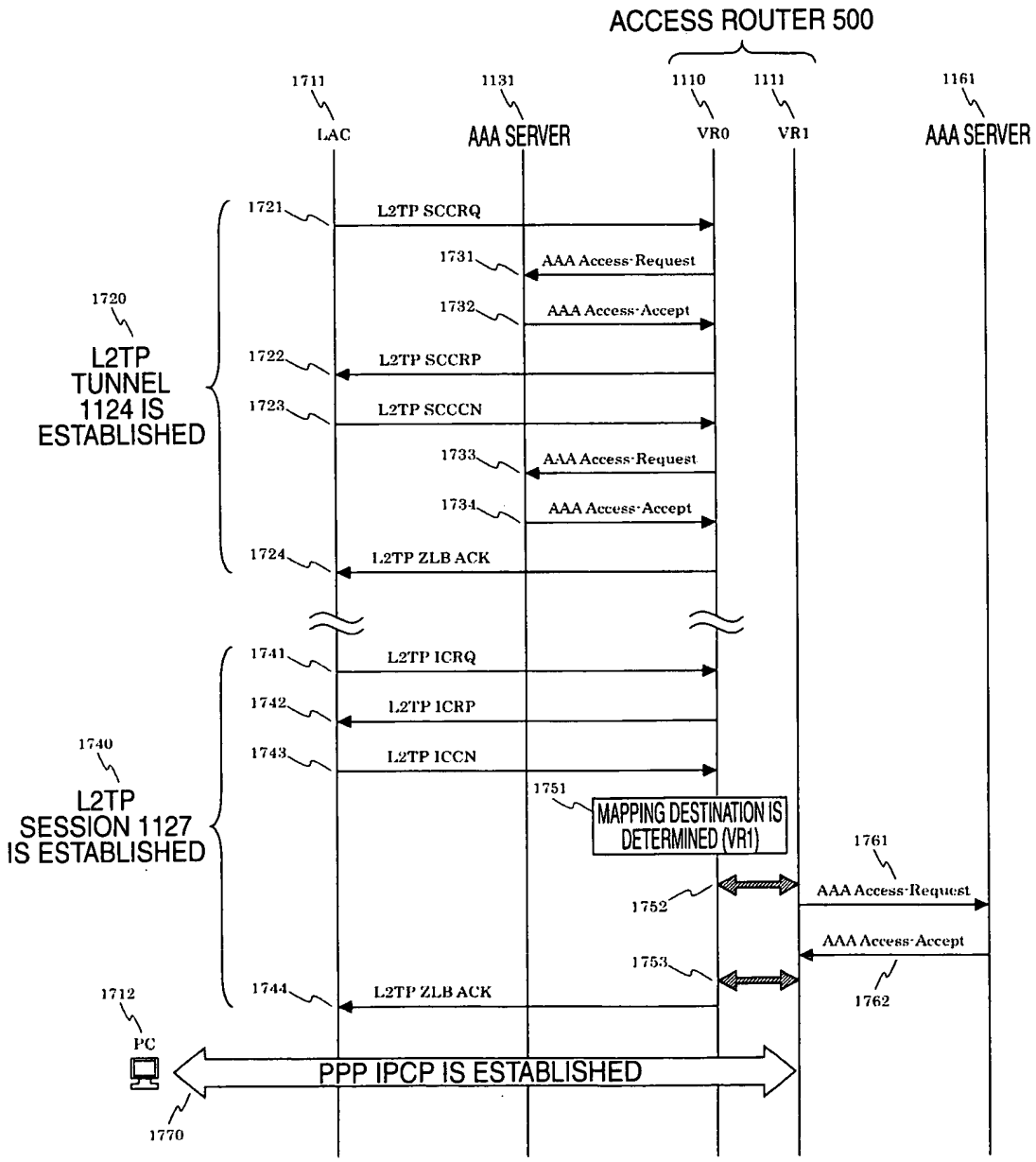
FIG. 20A

	2501 VIRTUAL ROUTER	2502 PHYSICAL I/F	2503 PROTOCOL	2504 LOGICAL I/F	2505 Rx/Tx	2506 ACTION	2507 VIRTUAL ROUTER
2521	-	Ether_21	IP	-	Rx	Route	VR_0
2523	VR_0	-	UDP/IP	UDP_1701	Rx	Decap_UDP/IP	VR_0
2524	VR_0	-	L2TP	Tunnel_21	Rx	Decap_L2TP	VR_1
2525	VR_1	-	PPP	Session_21	Rx	Decap_PPP	VR_1
2526	VR_1	-	IP	Session_21	Rx	Route	VR_1
2528	VR_1	Ether_22	IP	-	Tx	Forward	-
2531	-	Ether_22	IP	-	Rx	Route	VR_1
2533	VR_1	-	IP	Session_21	Tx	Encap_PPP	VR_0
2534	VR_0	-	PPP	Session_21	Tx	Encap_L2TP	VR_0
2535	VR_0	-	L2TP	Tunnel_21	Tx	Encap_UDP/IP	VR_0
2536	VR_0	-	IP	UDP_1701	Tx	Route	VR_0
2538	VR_0	Ether_21	IP	-	Tx	Forward	-

FIG. 20B

	2511 VIRTUAL ROUTER	2512 DESTINATION IP ADDRESS	2513 ADDRESS MASK	2514 SELF-ADDRESSED	2515 NextHop ADDRESS	2516 PHYSICAL I/F	2517 LOGICAL I/F
2522	VR_0	192.168.20.1	255.255.255.0	1	-	-	UDP_1701
2527	VR_1	158.214.2.5	255.255.255.0	0	158.214.1.1	Ether_22	-
2532	VR_1	133.144.69.112	255.255.255.0	0	-	-	Session_21
2537	VR_0	192.168.10.1	255.255.255.0	0	192.168.20.2	Ether_21	-

FIG. 21


ACCESS ROUTER 500
1711
LAC
1131
AAA SERVER
1110
VR0
1111
VR1
1161
AAA SERVER
1721
L2TP SCCRQ
1731
AAA Access-Request
1732
AAA Access-Accept
1720
L2TP TUNNEL 1124 IS ESTABLISHED
1722
L2TP SCCRP
1723
L2TP SCCCN
1733
AAA Access-Request
1734
AAA Access-Accept
1724
L2TP ZLB ACK
1741
L2TP ICRQ
1742
L2TP ICRP
1743
L2TP ICCN
1740
L2TP SESSION 1127 IS ESTABLISHED
1751
MAPPING DESTINATION IS DETERMINED (VR1)
1761
AAA Access-Request
1752
AAA Access-Accept
1753
1762
1744
L2TP ZLB ACK
1712
PC
PPP IPCP IS ESTABLISHED
1770